favourable impression. Sugar analysis, for example, which is often treated much too scantily in general treatises, receives adequate attention in the work under review. This chapter, in fact, is excellent, and one of the best in the book. The section on milk is quite good generally, but for use in this country it would have been improved by including the standard requirements and adapting it to English practice, much in the same way as the chapter on beer has been treated. Of the other sections, those on spirituous liquors, colouring matters, and textile articles may be singled out for commendation. The Allen-Marquardt method of determining higher alcohols, however, is not included in the first-mentioned group; presumably it is not in favour with Italian chemists.

Occasional references are given, but more might well be included, for the benefit of readers who may wish to consult the original descriptions. For example, both the Denigès colorimetric and Thorpe and Holmes's gravimetric method of estimating methyl alcohol are described, but without reference either to the authors or to the original papers.

These omissions, however, are minor matters. The work, as a whole, will be found useful and practical; it well deserves a place in the analyst's library. A meed of praise is certainly due to the translator, who has done his work very well indeed.

C. Simmonds.

OUR BOOKSHELF.

Contouring and Map-reading. By B. C. Wallis. Pp. 48. Price 2*s.*

Macmillan's Geographical Exercise Books: VII.—Physical Geography. With Questions. By B. C. Wallis. Pp. 48. (London: Macmillan and Co., Ltd., n.d.) Price 1*s.* 6*d.*

These books, which form parts of a series by the same author, have the advantage of being compiled by a teacher of wide experience who has given much thought to the presentment and mapping of geographical data. Mr. Wallis has shown considerable ingenuity in devising some of his exercises, and to a great degree has managed to avoid the trivial and merely mechanical tasks which often make such work irksome and of little value. In the volume on contouring and map-reading, which is specially to be recommended, advantage has been taken of the interest the war has given to geographical study in making use of many excellent war-maps in setting questions. Attention should also be directed to the exercises in making sketches from contour maps, though perhaps the method requires rather more explanation than is offered. In the glossary in the volume on physical geography the definition of barometric gradient requires revision. But the feature that gives the books great value is that every exercise has to be done on an accompanying map or diagram. The maps are clear and well printed, even to the smallest details. These books should give pupils an excellent grounding in the use and construction of maps.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

The Perception of Sound.

I would first thank those correspondents who have replied to my difficulties with respect to certain theories of the function of the cochlea. Unfortunately, the fundamental physical difficulty has not received the consideration that I hoped for, probably because it was not made sufficiently clear. Sir Thomas Wrightson (Nature, November 7) gives a quotation from Helmholtz which does not seem to me to meet the case, but perhaps it was written in connection with a different aspect of the problem. It is not obvious how the dimensions of the space filled with liquid in relation to the wave-length of the vibrations affect the nature of the process. If it were the case, the conduction of sound in liquids should be of a different nature according to the dimensions of the vessel and the pitch of the note. May I, therefore, put the question in another way?

When sound-waves impinge on water and are conducted through it, there could not be the necessary condensations and rarefactions unless the mass of water in front of the advancing wave offered sufficient resistance by its inertia to enable the local compression to take place. If the column of water moved as a whole in the way assumed by Sir Thomas Wrightson's theory, it could not conduct sound-waves as such, since there would be no possibility for the formation of any local differences of density. Now the impulses impressed by the stapes on the liquid of the cochlea are identical in time-course with sound-waves, and the nature of the disturbances in this liquid must be the same as if it were conducting sound. Of course, the column of liquid moves as a whole to relatively slow rates of incidence of energy. If a short, sharp tap be made on a membrane at one end of a column of water, the ear at the other end does not perceive the sound at the moment at which the blow is given; the transmission is by a wave. If it were necessary that the whole column of water should be moved, a large expenditure of energy would be required. It seems to be assumed that the force available is too small to do anything but move the liquid column in the cochlea as a whole, unequal to effect anything in the nature of a compression. But is this so? The force is concentrated into a very minute space. On the whole, I can see no alternative but the conclusion that the waves to which the organ of Corti responds are the same as sound-waves. I regret that Lord Rayleigh in his letter (Nature, November 21) has overlooked this point, about which his statement would have carried so much weight. It is important, however, that he does not see so many difficulties in the resonance theory as others do.

I cannot quite follow Sir Thomas Wrightson's explanation how there is produced a difference of pressure between the two sides of the basilar membrane. It seems to assume that there is a wave of pressure—that is, a sound-wave. Although the helicotrema is small, the volume of liquid moved through it is very minute (0·075 cub. mm. as a maximum, p. 96 of Sir Thomas Wrightson's book), and the existence of a difference of mechanical pressure is difficult to believe. The hairlets would not be bent unless there were such a difference.

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When Sir Thomas Wrightson states that the strongest argument against the string instrument theory" is that the basilar membrane does not consist of separate strings, he forgets that this is not an essential part of the resonance theory. Helmholtz made his calculations on the assumption that the membrane is homogeneous, but has a greater tension laterally than longitudinally.

Prof. Keith (Nature, October 31) has pointed out that the work of Keith Lucas and Adrian on the "all-or-nothing" character of the nerve impulse was done on motor nerves only. I am obliged to him for doing so, and apologise for omitting to mention the fact. At the same time, we know of no such differences in the properties of motor and sensory nerves as to suggest a fundamental contrast of the kind required. There seems no inherent difficulty in the performance of similar experiments on sensory fibres, using the reflex as an indicator. Perhaps Dr. Adrian, when freed from his military duties, may find it possible to undertake the work. The results would be of great value.

I admit that the title of Sir Thomas Wrightson's book implies that the internal ear has analytical functions, but it is not easy to see what these are on his theory. In fact, Prof. Keith states on p. 159 of the book that the relegation of the powers of analysis to the cerebral cortex is the hypothesis advanced by Sir Thomas Wrightson.

With regard to the necessary function of all structures found in an organism, I think Prof. Keith must have misunderstood my words; for he would scarcely claim a functional importance for the details of such structures as the splint-bones of the modern horse. It is to be remembered that Helmholtz did not profess to account for the whole of the mechanism of the internal ear. He would no doubt have been the first to recognise the necessity for modifications and additions to his theory. When we find a particular mode of effecting a given object in living organisms, it by no means follows that this is the simplest or best conceivable. Structures already present, of ancestral origin, are taken into use.

As Lord Rayleigh points out, the crux of the matter is the applicability of Müller's law. The parallel between sound and light is not so much that between the perception of pitch and colour as the perception of the elements of an image on the retina, each of which must be transmitted by its own special nerve-fibre. This circumstance, together with Lord Rayleigh's difficulty of admitting the capacity of nerves to transmit 10,000 vibrations per second and that of the "all-or-nothing" property of motor nerves, shows that physical and anatomical considerations alone cannot decide the question, which is, in the end, one of physiology.

It does not seem impossible that investigations with the Einthoven galvanometer might throw light on the form of the impulses in the auditory nerve. Even if the wave-form were beyond the capacity of the instrument, the number of impulses per second in relation to those of the pitch of the note and the refractory period of the nerve might be determined.

Dr. Perrett's difficulties (Nature, November 7) relate to the extent of spread of a resonant vibration and to the perfection of damping. It seems to me to be unreasonable to bind Helmholtz to exact numerical data, considering the enormous difficulties involved in the determination of the physical constants of the auditory apparatus. Nor are the numerical values used by Helmholtz for approximate calculations to be regarded as the "keystone of his theory." At any rate, the amplitude of a resonant vibration in a membrane decreases very steeply as the maximal point is departed from, and the fact that below a certain intensity of stimulus a nerve-fibre is not excited at all suggests the possibility that the amplitude of vibration may be sufficiently great to be effective only in immediate proximity to the maximum.

The sudden cessation of the perception of a sound when its source ceases, as required by phonetics, is, as Dr. Perrett is aware, a question of the perfection of damping. I fail to see why we are necessarily limited to any particular value of the reduction in a given time by the cochlear apparatus, be this value one-tenth or otherwise. The fact that a resonant vibration may be practically "dead-beat" was made clear to me in a recent experience at an orchestral concert. The floor-board on which one of my feet rested resounded by vibration to a particular note, especially to the powerful one of the trombone or drum. But the interest lay in the fact that this vibration ceased instantaneously as soon as the exciting note ceased, doubtless owing to the effective damping by the benches and the feet of the audience.

There is one phenomenon which has not been referred to hitherto in the present discussion: the disputed question as to whether the different compound wave-forms produced by different phase relations of the same component tones affect the quality of the sound heard. Helmholtz stated that they did not, but other observers have stated the contrary. Sir Thomas Wrightson's theory would be able to account for a difference, but the resonance theory would not. Unfortunately, the statements are very contradictory, and it does not appear that the experiments made by those who found phase relation to be effective were such as to exclude differences other than those of phase in the complex tones produced.

The desirability of a decision of the question at issue, if possible, may serve as excuse for a further letter on my part, for the length of which I beg to apologise.

W. M. Bayliss.

University College, London.

International Prize for Scientific Work.

I have recently received from one of the secretaries of the Royal Academy of Turin a printed Latin notice of the conditions prescribed for the next award of an international prize of the net value of 9000 Italian lire founded by Cesare Alessandro Brussa, M.D. The prize is to be awarded to the *vir doctus* who has produced that which, in the judgment of the academy, is the most important and most useful invention or the most important work during the four years between January 1, 1915, and January 1, 1919, in any of the following departments of study:—Physics, or other branches of experimental science; natural history; mathematics (pure or applied); chemistry; physiology; pathology; geology; history; geography, or statistics.

Those who are proposing to compete for the prize are requested to send their inventions or their works to one of the secretaries of the academy (Prof. C. F. Parona, secretary for physical, mathematical, or natural sciences, or Prof. E. Stampini, secretary for moral, historical, or philological sciences) before January 1, 1919. Any works sent must be printed, but will not be returned (works in manuscript or typewritten are inadmissible). The academy may also award the prize to one who has not submitted any work. The prize is open *docto viro cujuslibet nationis*, but Italian members of the academy are not eligible.

Cambridge. J. E. Sandys.

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